Graphene-based catalytic membrane for water treatment

The search for improved catalysts and water treatment technologies is imperative for a sustainable future for all. Thus, the removal of water organic contaminants by advanced oxidation technologies (AOTs), in particular catalytic ozonation, heterogeneous photocatalysis and persulfate activation, was attempted during this PhD by developing graphene-based derivatives as catalysts and photocatalysts. Graphene oxide (GO) derivatives were tested in catalytic ozonation for oxalic acid removal, but a strong erosive action of ozone on these materials was observed. In order to protect the carbon phase, titanium dioxide nanoparticles were introduced as own catalytic phase and shield component. In the search for metal-free photocatalysts, undoped GO analogues, namely GO-H (Hummers' method) and GO-B (Brodie's method) were tested for the photocatalytic degradation of phenol. GO-B revealed an almost complete removal, under near-UV/Vis and visible irradiation, which could be explained by its unique surface chemistry, interlayer distance and photoluminescence. Regarding the persulfate (PS) activation studies, N-modified GO catalyst (rGO-H*-M (0.4)) was very active for phenol, given its elevated percentage of N-pyridinic and N-quaternary species. The rGO-H*-M (0.4) material was used to fabricate a membrane that was applied in a similar catalytic reaction. The results were promising under recirculation and continuous mode for the degradation of phenol and oxalic acid. Thus, the main goal of this thesis was accomplished, i.e. the development of a metal-free catalytic graphene-based membrane for water treatment.

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